Anatomical Cadaver Study of the Hotchkiss Over-the-Top Approach for Exposing the Anteromedial Facet of the Ulnar Coronoid Process: Critical Measurements and Implications for Protecting the Median Nerve

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Learning Objectives
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- The role of the anteromedial facet of the coronoid in stability and congruity of the ulnohumeral joint
- The advantages and disadvantages of the medial over-the-top approach to the elbow joint
- The course of the median nerve in relation to the anteromedial facet and elbow joint

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Purpose To measure distances from anatomical landmarks to the median nerve, and estimate the length of the flexor-pronator/flexor carpi ulnaris (FCU) detachment necessary to expose the anteromedial facet of the ulnar coronoid process (UCP) using the Hotchkiss over-the-top approach.

Methods Dissections were made of 20 fresh-frozen cadaveric upper limbs. Measurements were made of the shortest distance from the medial epicondyle to the median nerve, the distance from the medial epicondyle to the median nerve in line with the flexor-pronator/FCU interval, the shortest distance from the apex of the UCP to the median nerve, and the length of the flexor-pronator/FCU detachment necessary to expose the anteromedial facet of the UCP. Measurements were also made of the length of the ulnar insertion of the brachialis muscle and the shortest distances from the proximal and distal insertions of the brachialis muscle to the median nerve.

Results The distances and lengths were as follows: medial epicondyle to median nerve, 31 ± 3 mm; in line with the flexor-pronator/FCU interval, 43 ± 5 mm; from the apex of the UCP to the median nerve, 7 ± 2 mm; the detachment necessary to expose the UCP, 47 ± 6 mm; the ulnar insertion of the brachialis muscle, 27 ± 4 mm; and the proximal and distal insertions of the brachialis muscle to the median nerve, 14 ± 2 mm and 5 ± 1 mm, respectively.

Conclusions The length of the flexor-pronator/FCU detachment necessary to expose the anteromedial facet of the UCP was similar to the distance from the medial epicondyle to the median nerve in line with the flexor-pronator/FCU interval. The distance from the distal insertion of the brachialis muscle to the median nerve was 5 mm.

Clinical relevance The results of our study provide information on important points for surgeons to consider when performing distal exposure using the Hotchkiss over-the-top approach. (J Hand Surg Am. 2016;41(8):819–823. Copyright © 2016 by the American Society for Surgery of the Hand. All rights reserved.)

Key words Anteromedial facet fracture, cadaver study, Hotchkiss over-the-top approach, median nerve, ulnar coronoid process.

It has been recently recognized that the anteromedial facet fracture of the ulnar coronoid process (UCP) is a distinct type of coronoid fracture resulting from a varus, posteromedial rotational force. Left untreated, these fractures result in an incongruent articulation of the ulnohumeral joint under gravitational varus stress and a predisposition toward rapid posttraumatic arthritis.\(^1,2\) Although the best surgical approach depends on the presence of concomitant ligamentous and bony injury,\(^3,4\) a medial approach to the anteromedial facet of the UCP is usually required for reducing and repairing these fractures.\(^5\) The majority of anteromedial facet fractures are relatively large, shearing-type fragments that are well suited to buttress plating. Adequate plate positioning is important and largely dependent on adequate exposure of the fracture site.

One medial approach for reaching the anteromedial facet of the UCP is the over-the-top approach by Hotchkiss and Kasparyan (Hotchkiss over-the-top approach),\(^6\) which provides a favorable field of view of the anteromedial elbow joint through the internervous plane between the flexor-pronator mass (median nerve) and the flexor carpi ulnaris (FCU) (ulnar nerve). This approach is well suited to, and often used during, a medial approach for a stiff elbow and excision of heterotopic ossification, but it is also very useful for treating anteromedial facet fractures of the UCP. However, although the Hotchkiss over-the-top approach is useful for exposure of the elbow joint proximally, because the median nerve is directly below the ulnar head of the pronator teres in the distal portion, exposure of the elbow joint distally may be limited.\(^7\) It has been emphasized that, when the Hotchkiss over-the-top approach is extended in the distal direction, precise anatomical knowledge of the ulnar head of the pronator teres and the course of the median nerve are required.\(^7\) Whether or not the course of the median nerve interferes with the Hotchkiss over-the-top approach is unclear because the length of the muscle requiring detachment for the purpose of gaining adequate exposure may be unknown.

The aims of the present study were to measure the distances from anatomical landmarks, the medial epicondyle of the humerus and the ulnar insertion of the brachialis muscle, to the median nerve, and estimate
the length of the flexor-pronator/FCU detachment necessary to expose the anteromedial facet of the UCP.

MATERIALS AND METHODS

Twenty upper limbs were used, consisting of 10 right and 10 left limbs from 10 fresh-frozen cadavers (5 men and 5 women). The cadavers were obtained after our institutional review board approved this study. The average age at the time of death was 83.1 years (range, 68–98 years). The upper limbs had not undergone prior surgery and had no history of injury around the elbow. An anatomical dissection was performed with the elbow joint flexed at 30° and the forearm in a supinated position, according to the method reported by Hotchkiss and Kasparyan. We made skin incisions 7 cm in length proximally and distally from the medial epicondyle (14 cm in total). The medial antebrachial cutaneous and ulnar nerves were identified, released, and protected. The medial intermuscular septum was resected 5 cm from the medial epicondyle, and the brachialis muscle was reflected on the humeral periosteum, turned over on the humeral periosteum, and held with a retractor. After an anatomical dissection was performed with the elbow joint flexed at 30° and the forearm in a supinated position, according to the method reported by Hotchkiss and Kasparyan. We made skin incisions 7 cm in length proximally and distally from the medial epicondyle (14 cm in total). The medial antebrachial cutaneous and ulnar nerves were identified, released, and protected. The medial intermuscular septum was resected 5 cm from the medial epicondyle, and the brachialis muscle was reflected from the humeral periosteum, turned over on the humeral periosteum, and held with a retractor. The origin of the flexor-pronator mass was released from the medial epicondyle, detached, and elevated at the FCU interval to expose the anterior joint capsule. The retractor was removed and the median nerve was exposed. The distance from the medial epicondyle to the median nerve was measured. The shortest distance from the medial epicondyle to the medial margin of the median nerve and the distance from the medial epicondyle to line with the flexor-pronator/FCU interval was measured using digital calipers (Fig. 2). The anterior articular capsule was resected and the shortest distance from the UCP to the median nerve (3) was measured. A 1.3-mm steel wire was used to estimate the length of the flexor-pronator/FCU detachment necessary to expose the anteromedial facet of the UCP. The wire was inserted into the apex of the UCP perpendicular to the forearm axis, the retractor was removed, and detachment was extended distally. When the muscle tension on the wire and the bend in the wire disappeared without support from the retractor, the detachment length between the flexor-pronator and the FCU, from the medial epicondyle to the distal end of
the dissection along the interval of the FCU, was measured. This was determined to be the length of the flexor-pronator/FCU detachment necessary to expose the anteromedial facet of the UCP (Fig. 4). Finally, the skin incision was extended to measure the length of the ulnar insertion of the brachialis muscle, the shortest distance from the proximal insertion of the brachialis muscle to the medial margin of the median nerve, and the shortest distance from the distal insertion of the brachialis muscle to the medial margin of the median nerve (Fig. 5).

RESULTS

The shortest distance from the medial epicondyle to the medial margin of the median nerve was 31 ± 3 mm (range, 26–37 mm). The distance from the medial epicondyle to the medial margin of the median nerve, in line with the flexor-pronator/FCU interval, was 43 ± 5 mm (range, 36–52 mm). The shortest distance from the apex of the UCP to the median nerve was 7 ± 2 mm (range, 4–11 mm), and the length of the ulnar insertion of the brachialis muscle was 27 ± 4 mm (range, 20–36 mm). The shortest distance from the proximal insertion of the brachialis muscle to the medial margin of the median nerve was 14 ± 2 mm (range, 10–19 mm), and the shortest distance from the distal insertion of the brachialis muscle to the medial margin of the median nerve was 5 ± 1 mm (range, 4–8 mm).

The length of the flexor-pronator/FCU detachment necessary to expose the anteromedial facet of the UCP for internal fixation was 47 ± 6 mm (range, 40–64 mm). This length was almost the same as the distance from the medial epicondyle to the medial margin of the median nerve in line with the flexor-pronator/FCU interval.

DISCUSSION

Anatomical studies on the feasibility of a medial approach to expose the anteromedial facet of the UCP have been previously been reported. Huh et al quantified and compared the amount of exposure resulting from the FCU-splitting approach and the Hotchkiss over-the-top approach using 2-dimensional imaging software to evaluate the articular surface. They concluded that the FCU-splitting approach provides more osseous exposure of the anteromedial coronoid and proximal ulna than does the Hotchkiss over-the-top approach. However, no evaluation of the potential for injury to a nerve branch injury to the FCU during the FCU-splitting approach has been reported.

Ma and Chang conducted a detailed study on the attachment site of the brachialis for placement of a plate for repairing fractures of the UCP. They reported that a partial incision of the attachment site on the brachialis insertion is necessary to provide sufficient space to place a plate on the UCP. The authors did not examine the relationship between the brachialis attachment site and the course of the median nerve.

Hotchkiss and Kasparyan showed that the shortest distance from the medial epicondyle to the median nerve was 34 mm (range, 27–44 mm). The distance

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**FIGURE 4:** Dissection 4: A 1.3-mm steel wire was inserted into the apex of the UCP of the ulna, and the length of the flexor-pronator/FCU detachment necessary to expose the anteromedial facet of the UCP (4) was measured. The muscle retractor was used only for the photographs; thus, it was not in place during the measurements.

**FIGURE 5:** Dissection 5: The length of the ulnar insertion of the brachialis muscle (5), the shortest distance from the proximal insertion of the brachialis muscle to the medial margin of the median nerve (6), and the shortest distance from the distal insertion of the brachialis muscle to the medial margin of the median nerve (7) were measured.
from the medial epicondyle to the median nerve, in line with the flexor-pronator/FCU interval, was 36 mm (range, 31–42 mm), and the shortest distance from the apex of the UCP to the median nerve was 10 mm (range, 0.8–11 mm). They also reported the effect of inserting a retractor between the muscles and the humerus, which is an essential technique used during the procedure. The shortest distance from the medial epicondyle to the median nerve and the shortest distance from the UCP to the median nerve were increased, but there was no relationship between the use of a retractor and the distance from the medial epicondyle to the median nerve in line with the flexor-pronator/FCU interval.

Our study showed that the length of the flexor-pronator/FCU detachment necessary to expose the anteromedial facet of the UCP was approximately 47 mm. This length was measured while the muscles were retracted by a wire. This length approximated the distance from the medial epicondyle to the median nerve in line with the flexor-pronator/FCU interval. Hotchkiss and Kasparyan reported that the distance from the medial epicondyle to the median nerve in line with the flexor-pronator/FCU interval does not change even with the use of a retractor. This does not change the fact that the distance from the medial epicondyle to the median nerve in line with the flexor-pronator/FCU interval and the length of the flexor-pronator/FCU detachment necessary to expose the anteromedial facet of the UCP measured in our study are about equal. Therefore, when the Hotchkiss over-the-top approach is extended distally, the median nerve is close to the distal portion of the exposure, even though a retractor may be used.

Previous studies have measured the width of the ulnar insertion of the brachialis muscle and found results similar to those in our study. Our study showed that the shortest distance from the proximal insertion of the brachialis muscle to the median nerve was approximately 14 mm, and the shortest distance from the distal insertion of the brachialis muscle to the median nerve was approximately 5 mm. This information is important when a buttress plate is placed near the ulnar insertion of the brachialis muscle.

This study had several important limitations that may have had an impact on the observations. We studied a relatively small number of cadaveric limbs and used both the limbs of 10 individuals. The cadavers were all of elderly persons, and it is possible that the findings would have been different in young subjects with well-developed musculature. In all cases, the elbow was fixed in a flexed position at 30°, and the influence of the flexion angle of the elbow on the positional relationship of the median nerve was not examined. This study was performed in cadavers, so clinical factors such as the presence of edema and inflammation were not studied. Thus, actual distances may be slightly different under clinical conditions in which this exposure is used.

REFERENCES
